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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of: Yuichiro Konishi et al.

Serial No. 09/856,457

Group Art Unit: 1772

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Examiner: Chevalier, Alicia Ann

For: LIGHT GUIDE PLATE

DECLARATION UNDER 37 CFR 1.132

Honorable Commissioner of  
Patents and Trademarks  
Washington, DC 20231

Sir:

1. I, Teiji Kohara, declare and state as follows;
2. I am not an inventor of the above application.
3. I was employed by Zeon Corporation in 1987, where I have been engaged in research development of a cycloolefin polymer, hydrogenated polystyrene and other resins.
4. I was boss at ZEONEX laboratory of R&D Center in the following time.  
Konishi 1991-1994,  
Obuchi 1993-1994 and 1997-1999,  
Miyazaki 1997-1999,

Ishimaru 1993-1998.

### EXPERIMENT

1. Experiment Place:

R&D Center in Zeon Corporation

2. Experimenter:

The present experiments were conducted directly by or under the direction of Teiji Kohara.

3. Object of Experiment

To prove the fact that a soft polymer significantly affects on quality of a light guide plate by means of clarifying effects on the quality brought by mixing a soft polymer in a light guide plate formed by injection molding of a resin composition composed at least of a thermoplastic resin containing alicyclic structure and a soft polymer.

4. Experiment

[Experiment 1]

Bicyclo[2,2,1]hept-2-ene (hereinafter referred to as "NB") (118g) was added to a reaction vessel charged with 258 liters of cyclohexane at ordinary temperature in a flow of nitrogen gas and agitated for 5 minutes.

Triisobutylaluminum was added to a concentration in the system of 1.0 ml/liter. Next, ethylene was circulated, with agitation, at ordinary pressure to make the system an ethylene atmosphere. The autoclave was held at an inside temperature of 70°C and pressurized by ethylene to an inside pressure of 6 kg/cm<sup>2</sup> in gauge pressure. This was agitated for 10 minutes, then 5.0 liters of a toluene solution containing

isopropylidene(cyclopentadienyl)(indenyl)zirconium dichloride and methylalumoxan prepared in advance was added

to the system so as to initiate the copolymerization reaction of ethylene and NB. The concentration of the catalyst at this time was 0.015 mmol/liter of isopropylidene(cyclopentadienyl)(indenyl)zirconium dichloride to the entire system. The concentration of methylalumoxane was 7.5 mmol/liter.

During the polymerization, ethylene was continuously fed into the system to hold the temperature at 70°C and the internal pressure at 6 kg/cm<sup>2</sup> in gauge pressure. After 50 minutes, the polymerization reaction was stopped by addition of isopropyl alcohol. After the depressurization, the polymer solution was taken out, then brought into contact with an aqueous solution comprised of 1 m<sup>3</sup> of water plus 5 liters of concentrated hydrochloric acid in a 1:1 ratio under strong agitation to cause the catalyst residue to move to the aqueous phase. The contact mixture was allowed to stand, then the aqueous phase was separated and removed and the remainder rinsed twice with water to purify and separate the polymerization solution phase.

The reaction solution was passed through a guard filter, then removed of the solvent and monomer and other volatile components by direct drying using a centrifugal thin film continuous evaporation drier. The obtained molten resin was palletized by a melt extruder to obtain a copolymer (A) of ethylene and NB.

The weight average molecular weight  $M_w$  of the ethylene-NB copolymer (A) obtained in this way measured converted to polyisoprene by a GPC (gel permeation chromatograph) using cyclohexane as a solvent was 38000, the molecular weight distribution  $M_w/M_n$  was 2.37, the MFR

of the polymer was 55 [g/10min.], the 50% breaking energy was 0.63J, the glass transition temperature  $T_g$  was 140°C, the refractive index was 1.53, and the NB content calculated by  $^{13}\text{C}$ -NMR was 53 mol%.

[Experiment 2]

The same procedure was followed as in Experiment 1 other than making the reaction time 46 minutes to obtain an ethylene-NB copolymer (B) having an MFR of 65 [g/10min.], a 50% breaking energy of 0.48J, a  $T_g$  of 141°C, a refractive index of 1.53, and an NB content of 53%.

[Experiment 3]

1.22 parts by weight of 1-hexene diluted by 10 parts by weight of cyclohexane, 0.11 part by weight of dibutyl ether, and 0.22 part by weight of triisobutylaluminum were placed into a reaction vessel and mixed with 250 parts by weight of dehydrated cyclohexane in a nitrogen atmosphere at room temperature, then 100 parts by weight of tricyclo [4,3,0,1<sup>2,5</sup>] deca-3,7-diene (hereinafter referred to as DCP) and 30 parts by weight of a 0.70 wt% toluene solution of tungsten hexachloride were continuously added over 2 hours while holding the mixture at 45°C for polymerization. The adjusted polymerization reaction solution was transported as it was to a pressure-resistant hydrogenation reactor, 10 parts by weight of a diatomaceous earth-carrying nickel catalyst were added, and a reaction was caused at 180°C at a hydrogen pressure of 45 kgf/cm<sup>2</sup> in gauge pressure for 10 hours. This solution was filtered by a filter provided with a stainless steel mesh using diatomaceous earth as a filtration aid to remove the catalyst. The obtained reaction solution was poured into 3000 parts by weight of

isopropyl alcohol with agitation to cause the precipitation of the hydrogenate. This was then recovered by filtration. Further, the filtrate was washed by 500 parts by weight of acetone, then dried in a reduced pressure drier set to not more than 1 torr and 100°C to obtain 95 parts by weight of a ring-opening polymer hydrogenate (C). The MFR of the obtained ring-opening polymer hydrogenate (C) was 54 [g/10min.], the ratio of the repeating units including an alicyclic structure in the total polymer repeating units was 100 mol%, the TG was 94°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (Mw) obtained by high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 31500, and the molecular weight distribution (Mw/Mn) was 2.10.

[Experiment 4]

The same procedure was followed as in Experiment 3 other than making the amount of addition of 1-hexene added 1.35 parts by weight to obtain a ring-opening polymer hydrogenate (D). The MFR of the obtained ring-opening polymer hydrogenate (D) was 185 [g/10min.], the ratio of the repeating units including an alicyclic structure in the total polymer repeating units was 100 mol%, the TG was 93°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (Mw) obtained by high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 19200, and the molecular weight distribution (Mw/Mn) was 2.08.

[Experiments 5 to 8]

0.5 part by weight of the phenol-based antioxidant

pentaerythrityl-tetrakis(3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate) and 0.02 part by weight of the hydrogenated styrene-butadiene-styrene block copolymer (Tuftec H1051 made by Asahi Kasei, crumbs, refractive index of 1.52 at 30°C) as a soft polymer were mixed in 100 parts by weight of respective polymers A to D obtained in Experiments 1 to 4 and kneaded by a twin-screw kneader, then the strands (strand shaped molten resin) were passed through a strand cutter to obtain a pellet- (granular) shaped molded material. These pellets were injection molded to prepare light guide plates A to D. The molding conditions of the injection molding were the use of an injection molding machine of Model IS450 made by Toshiba Machinery, a mold temperature of 80°C, a cylinder temperature of 280°C, a nozzle temperature of 260°C, an injection pressure of 1000 kgf/cm<sup>2</sup>, a holding pressure of 800 kgf/cm<sup>2</sup>, a mold clamping pressure of 1200 kgf/cm<sup>2</sup>, an injection speed (corresponding to screw speed of advance) of 40 mm/s, a screw back pressure of 70 kgf/cm<sup>2</sup>, and a screw speed of 30 rpm. Further, the time from the start of filling into the mold to the end of filling was 1 second.

[Experiments 9 to 12]

The same procedure was performed as in Experiments 5 to 8 except for not mixing the hydrogenated styrene-butadiene-styrene block copolymer (Tuftec H1051 made by Asahi Kasei, crumbs, refractive index of 1.52 at 30°C) as a soft polymer in the polymers A to D obtained in Experiments 1 to 4, and light guide plates E to H were produced.

The obtained light guide plates A to H, as shown in

FIG. 1A and FIG.1B, were a wedge shape having a thickness at wide end (100a side) of 2.2 mm, a thickness of the narrow end side (100d side) of 0.5 mm, a length from the wide end to the narrow end side of 190 mm, a length along the axial direction of the linear light source of 250 mm, and a gradually decreasing thickness in the direction from the wide end side to the narrow end side (direction substantially perpendicular to the center axis of the linear light source). At the time of mold release, no short shots or burrs were caused and no cracks on the molded items were observed. The light reflection face side of the light guide plate is formed with V-grooves becoming gradually denser the further from the wide end side of the light guide plate to the narrow end side. Note that the V-groove had an apical angle of  $110^\circ$ , a pitch near the light source of 0.3 to 1.5 mm, a pitch near the narrow end of 0.03 to 0.06 mm, and the depth of the groove was made a uniform one of about 80  $\mu\text{m}$ . The gate shown in FIG. 2 is positioned at the side close to the light incident face from the substantial center portion of the side of the emission face. The gate length was 50 mm and the gate thickness was 1.9 mm.

FIG.1A is a schematic perspective view of an outline of a planar light source device incorporating the light guide plate, FIG.1B is a sectional view of the planar light source device of FIG.1A, FIG.1C is an enlarged view of a key part of FIG.1B, and FIG.1D is an enlarged view of a part of a reflection face in FIG.1C.

FIG.2A is a sectional view of the light guide plate, and FIG.2B is a view of the bottom of the light guide plate shown in FIG.2A.

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## [Experiment 13]

Durability test was performed under a high temperature and high humidity environment by using the light guide plates obtained in Experiments 5 to 12. The light guide plates were left in a temperature and humidity controlled chamber wherein relative humidity was 90% and the temperature was 60°C for 500 hours, taken out abruptly to the room temperature environment (outside the testing device) and measured luminance thereof after 24 hours to inspect changes of luminance before and after the test. The luminance of light guide plates was obtained by using as a reflection sheet RF195E (made by Tsujiden Co., Ltd.) on the reflection face side, as diffusion sheet D122J (made by Tsujiden Co., Ltd.) on the emission face side, and as prism sheets BEF III-T (made by Sumitomo 3M Co., Ltd.) and RBEF-8M (made by Sumitomo 3M Co., Ltd.), measuring luminance on 25 points at regular intervals (in the vertical direction) on a long side and a short side on a light guide plate emission face stacked with the above sheet after a holding time of 30 minutes after turning off a lamp, and calculating an average value thereof. The result evaluated by obtaining a luminance maintaining rate from (average luminance after the test)/(average luminance before the test)×100 is shown below.



[Table 1]

Light Guide Plate	Luminance Maintaining Rate
Light Guide Plate A (Corresponding to Embodiment 1 in Specification of Present Invention)	89%
Light Guide Plate B (Corresponding to Embodiment 2 in Specification of Present Invention)	90%
Light Guide Plate C (Corresponding to Embodiment 7 in Specification of Present Invention)	94%
Light Guide Plate D (Corresponding to Embodiment 8 in Specification of Present Invention)	93%
Light Guide Plate E (Case of not mixing with soft polymer in Embodiment 1 in Specification of Present Invention)	35%
Light Guide Plate F (Case of not mixing with soft polymer in Embodiment 2 in Specification of Present Invention)	30%
Light Guide Plate G (Case of not mixing with soft polymer in Embodiment 7 in Specification of Present Invention)	40%
Light Guide Plate H (Case of not mixing with soft polymer in Embodiment 8 in Specification of Present Invention)	50%

## 5. Consideration

From Experiment 13, it became clear that a high luminance maintaining rate was obtained in the high temperature high humidity test as a result that a soft polymer was mixed in a thermoplastic resin containing alicyclic structure (the light guide plates A to H).

The cited articles (the Japanese Unexamined Patent Publication No. 07-118344, the Japanese Unexamined Patent Publication No. 08-94852 and the U.S. Patent Number 5,516,456) do not describe mixing of soft polymer nor effects thereof exhibited in a high temperature high

humidity test.

However, as is obvious from the present experiment, mixture of a soft polymer clearly brings effects in the high temperature high humidity test of a light guide plate made by the thermoplastic resin containing alicyclic structure obtained in the present experiments. Accordingly, the present invention was not made by a person skilled in the art by applying the resin described in the Japanese Unexamined Patent Publication No. 07-118344, the Japanese Unexamined Patent Publication No. 08-94852 and the U.S. Patent Number 5, 516, 456 to the invention (light guide plate) described in 549.

I declare further that all statement made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements are the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful, false statements may jeopardize the validity of the application or any patent issuing thereon.

FURTHER, DECLARANT SAYETH NOT

Date: July 31, 2003

Teiji Kohara  
Teiji Kohara